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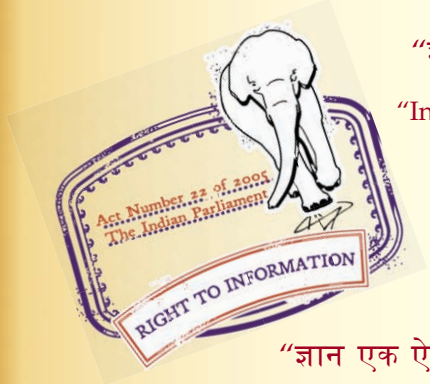

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Indian Standard

METHODS FOR SAMPLING OF LIGHT METALS AND THEIR ALLOY PRODUCTS

UDC 669·2/·8 : 620·113

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 1

November 1966

Indian Standard

METHODS FOR SAMPLING OF LIGHT METALS AND THEIR ALLOY PRODUCTS

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Indian Standard

METHODS FOR SAMPLING OF LIGHT METALS AND THEIR ALLOY PRODUCTS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 5 August 1966, after the draft finalized by the Methods of Sampling Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 The indigenous production and use of light metals and their alloy products have considerably increased during the last few years. Besides, the versatility of these metals and their alloy products is likely to further enhance their consumption in the various industries. It is, therefore, imperative that at this stage of development and expansion of the light metal industry, due consideration is given to the sampling procedures which will help in proper and objective evaluation of the physical/chemical characteristics of these products.

0.2.1 Proper quality control during the process of manufacture would also substantially reduce the quality fluctuations of the ultimate products. The sampling procedures recommended in this standard, therefore, include the provisions for both process control and product inspection.

0.3 The recommendations made in this standard are intended to meet the needs of sampling of light metals and their alloy products for general engineering purposes. As regards the requirements of aircraft industry, it was felt desirable to have a separate standard on the sampling of such metals in view of the necessity to having more rigid inspection and control provisions.

0.4 This standard contains clauses **4.3.1** and **4.4.1** which call for agreement between the purchaser and the supplier.

0.5 In reporting the results of test or analysis, if the final value observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard prescribes the methods for sampling and the criteria for conformity for light metals and their alloy products. Broad outlines with regard to the controls to be exercised during the manufacturing process have also been indicated.

1.1.1 The sampling of light metals and their alloy products used in the aircraft industry has not been covered in this standard.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Item — A unit such as an ingot, casting, forging, bar, rod, wire, plate, sheet, strip, etc, meant for inspection/testing.

2.2 Lot — A collection of items of light metals and their alloy products of one type (such as, ingots, plates, bars, etc) and size (such as, weights for ingots, thickness for plates and cross-section for bars) manufactured from a single melt, cast or heat.

2.3 Defect — Failure to meet the requirement imposed on an item with respect to a single characteristic.

2.4 Defective — An item having one or more defects.

2.5 Acceptance Number — The maximum permissible number of defectives in the sample for acceptance of the lot.

2.6 Acceptable Quality Level (AQL) — The maximum percent defective that, for the purpose of sampling of light metals and their alloy products can be considered as satisfactory process average.

NOTE — When a purchaser designates some specific value of AQL, he indicates to the supplier that his (the purchaser's) acceptance sampling plan will accept the great majority of the lots that the manufacturer submits, provided that the process average level of percent defective in these lots be not greater than the designated value of AQL. Thus, the AQL is a designated value of percent defective that the purchaser indicates will be accepted most of the times (approximately 89 to 99 percent).

2.7 Supplier — The party supplying the material. The supplier may or may not be the actual manufacturer of the material.

2.8 Purchaser — The party purchasing the material. The term 'purchaser' shall also cover person or persons expressly authorized in writing by the purchaser to act on his behalf for inspection of the material.

3. PROCESS INSPECTION

3.1 The object of inspecting light metals and their alloy products by the purchaser is to ensure their conformity to the specification requirements, whereas inspection done by the manufacturer during production is to ensure conformity to relevant specifications as also to maintain more uniform quality. For production control, the manufacturer should take representative samples of the material at regular intervals to control the quality fluctuations. The inspection levels given in Table 1 are recommended for routine control over the manufacturing process.

3.2 Methods of Drawing Samples

3.2.1 *Ingots* — The required number of samples shall be prepared by pouring spoonfuls of molten metal into moulds of desired sizes, and obtaining heavily chilled test ingots. Care shall be taken to avoid dust and slag.

3.2.2 *Castings* — The required number of test specimens shall be cast either integrally or separately for each melt. In the case of large and highly stressed castings the test pieces should be cast both before and after pouring the castings. The actual position of the tensile test pieces integrally cast may depend upon the size, intricacy and the highly stressed regions.

NOTE — It should be emphasized that separately cast test bars indicate only the properties of the metal before entry into the mould and bear little relation to the properties of the metal in the castings; and that the data obtained on actual castings may be entirely different and more valuable than those obtained from separately cast or cast-on test bars.

3.2.2.1 Samples for chemical analyses should be cast in chill moulds or drilled directly from the castings or from used mechanical test specimens representative of the casting.

3.2.3 *Forgings* — In the preparation of test samples the following points shall be taken care of:

a) Cast billets or extrusion blanks for finished forgings are free from harmful internal defects;

b) Heat treated pieces from test-coupon forged from stock are tested;

c) Integrally forged blanks which should be representatives of the *highly stressed regions are tested, ensuring that the flow lines* follow the contour;

d) Pieces from the forging itself are tested in addition to those from initial rolled and extruded forging-blanks; and

e) Flow-lines, residual stress concentrations, grain structures and responses to heat treatment are studied.

NOTE — Such characteristics such as toughness, grain structure, flow and residual stress concentrations of actual forgings may be entirely different and more valuable than those obtained from separately or even integrally forged blanks.

TABLE 1 RECOMMENDED LEVELS OF INSPECTION/TESTING

(*Clause* 3.1)

Sl No.	Unit of Inspection	Frequencies of Inspection/No. of Tests for			
		Visual Characteristics	Dimensional Characteristics	Physical Properties	Chemical Analysis
(1)	(2)	(3)	(4)	(5)	(6)
i)	Ingots, notch bars, shots, etc, for remelting or for use in steel production	—	—	—	2 for batch melting (one taken at the beginning and the other at the end of pouring) One for every 5 000 kg or part thereof for continuous melting
ii)	Ingot for fabrication	All	One for every 10 or less	—	Same as above
iii)	Casting	All	One for every 10 or less in case of permanent moulds Every casting for sand moulds	3 standard test samples for a lot	One for each batch of castings poured from a melt
iv)	Forging	All	One for every 10 or less	3 standard test samples for a lot	2 from the items heat treated in a single furnace charge
v)	Bar, rod, wire or shape*	All	One for every 10 items or less	3 items for a lot	Need not be done in case adequate tests have been conducted on ingots for fabrication
vi)	Sheet, plate or strip*	All	One for every 10 items or less	3 items for a lot	
vii)	Pipe or tube*	All	One for every 10 items or less	3 items for a lot	

*For bars, rods, sheets, plates, pipes and tubes which are supplied in the coil form, both the end portions may be checked for visual and dimensional characteristics.

3.2.3.1 For chemical analysis, the drillings may be taken from the centre of the solid forgings. For this purpose the forging from which the mechanical test specimens are prepared may be used.

3.2.4 *Extruded and Rolled Products* — Mechanical test specimens shall be prepared in the as-received condition and after heat treatment, if any. In the case of products intended for highly stressed members, test specimen shall be drawn from extruded sections of each original cast billet.

3.3 For effective production control, the use of statistical quality control techniques is also recommended and helpful guidance may be obtained in this respect from IS : 397-1952*.

3.4 On the basis of the process inspection data, the manufacturer may issue relevant test certificate to prove the conformity of a lot to the requirements of any specification.

3.4.1 When such test certificate cannot be made available to the purchaser or when the purchaser so desires, the procedure laid down in **4** shall be followed for judging the conformity or otherwise of a lot of light metals and their alloy products to the requirements of relevant specification.

4. LOT INSPECTION

4.1 The samples shall be selected and examined for each lot (*see* **2.2**) separately for ascertaining their conformity to the requirements of the relevant specification.

4.2 The number of items to be selected from a lot shall depend upon the size of the lot and shall be in accordance with col (1) and (2) of Table 2. All these items shall be taken at random from the lot either with the help of a suitable random number table or any other suitable means.

4.3 All the items as drawn under **4.2** shall be examined for visual characteristics such as workmanship, finish and freedom from defects, in accordance with the details given in the relevant specification. Any item shall be considered as a defective if it is non-conforming with respect to any of the visual characteristics under consideration. If the number of defective items found in the sample is less than or equal to the corresponding acceptance number given in col (3) of Table 2,

*Method for statistical quality control during production by the use of control chart.

the lot shall be declared as conforming to the requirements of visual characteristics. If however, the number of defective items is found to be greater than the corresponding acceptance number, the lot shall be deemed as not having met the requirements of visual characteristics.

TABLE 2 SCALE OF SAMPLING AND PERMISSIBLE NUMBER OF DEFECTIVES FOR VISUAL AND DIMENSIONAL CHARACTERISTICS

(*Clauses* 4.2, 4.3 *and* 4.4)

No. of Items in the Lot	For Visual Characteristics		For Dimensional Characteristics	
	No. of Items to be Selected	Acceptance Number	No. of Items to be Selected	Acceptance Number
(1)	(2)	(3)	(4)	(5)
Up to 15	5	0	3	0
16 to 25	8	0	5	0
26 ,, 50	13	1	8	0
51 ,, 100	20	1	13	0
101 ,, 150	32	2	20	0
151 ,, 300	50	3	32	1
301 ,, 500	80	5	50	2
501 ,, 1 000	125	7	80	3
1 001 ,, 3 000	200	10	125	5
3 001 ,, 10 000	315	14	200	7
10 001 and above	500	21	315	10

NOTE — The associated AQL's (*see* **2.6**) for visual characteristics and dimensional characteristics are 2·5 percent and 1·5 percent respectively. These AQL values will strictly hold good only in the case of larger lots.

4.3.1 In the case of those lots which have been found unsatisfactory according to **4.3**, all the items in the lot may, depending upon the agreement between the purchaser and the supplier be inspected for visual characteristics and the defective ones removed.

4.4 The lot which has been found satisfactory in respect of visual characteristics (*see* **4.3**) shall next be tested for dimensional characteristics like thickness, length, etc. The number of items required for this purpose shall be in accordance with col (1) and (4) of Table 2 (these may be chosen from the sample items already selected for the purpose of examination of visual characteristics). Any item failing to meet one or more dimensional requirements shall be considered as a defective. If the number of defectives found is less than or equal to the corresponding acceptance number given in col (5) of Table 2, the lot shall be deemed as having met the dimensional requirement of the relevant specification, otherwise not.

4.4.1 In the case of those lots which have been found unsatisfactory according to **4.4**, all the items in the lot may, depending upon the agreement between the purchaser and the supplier, be inspected for dimensional characteristics and the defective ones removed.

4.5 The lot which has been found satisfactory in respect of visual and dimensional requirements (*see* **4.3** and **4.4**) shall next be tested for physical characteristics like tensile strength, bend test, hardness, etc. The items required for this purpose shall be taken at random from those already drawn (*see* **4.2**) in accordance with col (1) and (2) of Table 3.

TABLE 3 SCALE OF SAMPLING FOR PHYSICAL CHARACTERISTICS

No. of Items in the Lot	No. of Items to be Selected
(1)	(2)
Up to 50	2
51 to 150	3
151 ,, 500	5
501 and above	8

4.5.1 From each of the items so chosen (*see* **4.5**) the required number of test specimen shall be prepared for conducting the physical tests specified. The manner of preparation of test specimen as well as their dimensions shall be in accordance with the relevant specifications.

4.5.2 From the different test results for each of the measurable characteristics the average ($\bar{X}$) and range (R) shall be calculated as follows:

$$\text{Average } (\bar{X}) = \frac{\text{The sum of test results}}{\text{The number of test results}}$$

Range (R) = The difference between the maximum and minimum values of the test results

4.5.2.1 If the specification limit for the characteristic is given as a minimum then the value of the expression ($\bar{X} - kR$) shall be calculated from the relevant test results. If the value so obtained is greater than or equal to the minimum limit, the lot shall be declared as conforming to the requirement of that characteristic.

4.5.2.2 If the specification limit for the characteristic is given as a maximum, then the value of the expression ($\bar{X} + kR$) shall be calculated from the relevant test results. If the value so obtained is less than or equal to the maximum limit, the lot shall be declared as conforming to the requirement of that characteristic.

4.5.2.3 If the characteristic has two-sided specification limits then the value of the expression ($\bar{X} - kR$) and ($\bar{X} + kR$) shall be calculated from the relevant test results. If the values so obtained lie between the two specification limits, the lot shall be declared as conforming to the requirement of that characteristic.

4.5.2.4 The value of the factor k referred to in **4.5.2.1** to **4.5.2.3** shall be chosen in accordance with Table 4 depending upon the desired acceptable quality level (*see* **2.6**).

TABLE 4 VALUES OF k FOR ACHIEVING DIFFERENT ACCEPTABLE QUALITY LEVELS

ACCEPTABLE QUALITY LEVEL, PERCENT	VALUE OF k
2·5 to 4·5	0·4
1·0 and up to 2·5	0·5
Less than 1·0	0·6

4.5.3 In the case of those characteristics like the bend test which are not measurable on a continuous scale, the lot shall be considered as conforming to the requirement of the specification if each of the test results is found to be satisfactory.

4.5.3.1 In case any test specimen representing an item fails in any of the physical tests, two additional specimens drawn from the same item shall be subjected to the particular test in which failure has occurred to account for any testing error. If both these additional specimens pass the particular test the item from which they are drawn shall be considered as satisfactory.

4.6 For each lot, a minimum of two analyses shall be made for the determination of the various chemical constituents of the alloy as laid down in the relevant specification.

4.6.1 In the case of finished products, chemical analysis should preferably be done by remelting or alternatively by getting test specimens which are cast along with ingots for fabrication. Taking specimens from the item itself should be the last resort.

4.6.2 In the case of clad material, drillings or chips shall be obtained from the selected items from the core only, that is, after stripping the cladding. For the purpose of removing the clad material, etching the sheet with Keller's reagent is recommended. The etching may be done by dipping the sample in reagent and cleaning it every 15 minutes or so till the clad material is completely removed. A cross section of the

sample piece under microscope may be checked to ensure the complete removal of the clad material.

4.6.3 All other general principles of preparing the samples needed for chemical analysis shall be in accordance with IS : 1817-1961*.

4.6.4 The lot shall be deemed as conforming to the chemical requirements of the relevant specification if both the analyses are found to be satisfactory.

*Methods of sampling non-ferrous metals for chemical analysis.

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